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HSTP-IPTV-GUIDE.1
IPTV service deployment scenarios in high-speed broadband era

ITU-T

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Summary

This Technical Paper introduces two solutions for linear TV service for retransmission of broadcast service over IPTV. The first one adopts the transcoders to reduce the bandwidth of the service. The second one, the future solution in high-speed broadband era, does not use the transcoders. Both solutions provide services that can be received by IPTV terminal devices (basic model). The choice of the following scenarios will be decided by service operators by considering the matureness of the technologies and the business model.

Keywords

Change Log

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1   Scope

This Technical Paper introduces two scenarios for linear TV service for retransmission of broadcast service over IPTV. The first one adopts transcoders to reduce service bandwidth. The second one, a future solution in the high-speed broadband era, does not use transcoders. Both scenarios provide services that can be received by IPTV terminal devices (TDs) following the basic model [ITU-T H.721]. The choice of scenario will be made by service operators taking into account the maturity of the technologies and business models.

2   References

The following ITU-T Technical Papers and other references contain provisions which, through reference in this text, constitute provisions of this Technical Paper. At the time of publication, the editions indicated were valid. All Technical Papers and other references are subject to revision; users of this Technical Paper are therefore encouraged to investigate the possibility of applying the most recent edition of the Technical Papers and other references listed below. A list of the currently valid ITU-T Technical Papers is regularly published. The reference to a document within this Technical Paper does not give it, as a stand-alone document, the status of a Technical Paper.

[ATIS-0800002]	ATIS standard ATIS-0800002 (2006), *IPTV Architecture Requirements*. https://www.atis.org/docstore/product.aspx?id=21213
[ITU-R BT.2020]	Recommendation ITU-R BT.2020 (2012), *Parameter values for ultra-high definition television systems for production and international programme exchange*.
[ITU-T H.262]	ITU-T Recommendation H.262 (2000), *Information technology – Generic coding of moving pictures and associated audio information: Video*.
[ITU-T H.264]	ITU-T Recommendation H.264 (2007), *Advanced video coding for generic audiovisual services*.
[ITU-T H.265]	Recommendation ITU-T H.265 (V4) (2016), *High Efficiency Video Coding*.
[ITU-T H.622.1]	Recommendation ITU-T H.622.1 (2008), *Architecture and functional requirements for home networks supporting IPTV services*.
[ITU-T H.720]	Recommendation ITU-T H.720 (2008), *Overview of IPTV terminal devices and end systems*.
[ITU-T H.721]	Recommendation ITU-T H.721 (2015), *IPTV terminal devices: Basic model*.
[ITU-T J.190]	Recommendation ITU-T J.190 (2007), *Architecture of MediaHomeNet*.
[ITU-T V.152]	Recommendation ITU-T V.152 (2010), *Procedures for supporting voice-band data over IP networks*.
[ITU-T X.1191]	Recommendation ITU-T X.1191 (2009), *Functional requirements and architecture for IPTV security aspects*.
[ITU-T Y.1901]	Recommendation ITU-T Y.1901 (2009), *"Requirements for the support of IPTV services."*
[ITU-T Y.1910]	Recommendation ITU-T Y.1910 (2008), *IPTV functional architecture*.

3 Definitions

3.1 Terms defined elsewhere

This Technical Paper uses the following terms defined elsewhere:

3.1.1 delivery network gateway (DNG) [ATIS-0800002]: A device implementing the delivery network gateway function (DNGF).

NOTE – Many terms such as home access [ITU-T J.190], home gateway, residential gateway, delivery network gateway and so on are used for the same device.

3.1.2 delivery network gateway functions (DNGF) [ITU-T H.622.1]: Set of functions that mediate between the network and service provider domains and the IPTV terminal function.

NOTE – A device implementing the DNGF is commonly referred to as the residential gateway or delivery network gateway (DNG).

3.1.3 transcoding [ITU-T V.152]: Translation from one type of encoded media format to another different media format (examples: ITU-T G.711 A-law to μ-law or vice versa, ITU-T G.711 codec to ITU-T G.726-40K, ITU-T G.711 to a broadband codec that operates at 256 kbit/s, etc.).

3.2 Terms defined in this Technical Paper

This Technical Paper defines the following terms:

3.2.1 IP broadcasting gateway (IBGW): The device in end-user functions receives IPTV signals over an IP network from a delivery network gateway (DNG) and outputs a broadcast signal to the broadcast network that connects to TV sets. The output signal is interpreted by the TV set as the original broadcast signal.

NOTE – IBGW supports only the input signal based on scenario 2 in clause 6.

4 Abbreviations and acronyms

This Technical Paper uses the following abbreviations and acronyms:

ATSC	Advanced Television Systems Committee
BC-NW	Broadcast network
CAS	Conditional access system
DNG	Delivery network gateway
DNGF	Delivery network gateway functions
DRM	Digital right management
EPON	Ethernet-passive optical network
HE	Head-end
IBB	Integrated broadcast-broadband
IBGW	IP broadcasting gateway
IP	Internet protocol
ISDB-S3	Integrated Services Digital Broadcasting for Satellite, 3rd generation
MMTP	MPEG Media Transport Protocol
TS	(MPEG) Transport Stream
TD	Terminal device
TD-OD	Terminal device - output device
TD-SM	Terminal device - security module [ITU-T H.720]
TD-PD	Terminal device - peripheral device [ITU-T H.720]
SCP	Service and content protection
SI	(DVB) Service Information
UHDTV	Ultra high definition television

5   Introduction

In order to deploy IPTV service, it is important to deliver the popular contents such as programs of broadcast service. In the requirement Technical Paper of IPTV services [ITU-T Y.1901], IPTV service for retransmission of broadcast service, a kind of Linear TV service, are described. This Technical Paper describes the guideline to introduce two solutions for linear TV service for retransmission of broadcast service. The first one is now deployed in Japan. The second is the future solution in high-speed broadband era. Both solutions provide services that can be received by IPTV terminals (basic model). The choice of the following scenarios will be decided by service operators by considering the matureness of the technologies and the business model.

6   IPTV deployment scenarios in high-speed broadband era

This Technical paper focus on two scenarios:

–   **Scenario 1: Delivering programs with transcoding them using of the latest codec**

IPTV systems for retransmission of terrestrial broadcast service are deployed in Japan [b-IPTVforum]. IPTVforum adopted transcoding from MPEG-2 video [ITU-T H.262] to H.264 [ITU-T H.264] to reduce the network bandwidth. Transcoding has been one of the key components in network bandwidth reduction for IPTV services. In IPTV service for retransmission of broadcast service with transcoders, contents (programs) are decrypted before transcoding them and then re-encrypted before delivering them as IPTV service. By this service, an IPTV basic TD can receive the same terrestrial broadcast programs as received by ordinary TV sets.

As video coding technologies progress, the video codec that were adopted for the broadcast service is not the latest technology when compared to the ones used in IPTV services. Transcoding from a current broadcast codec to the latest codec is useful to reduce network bandwidth usage.

–   **Scenario 2: Delivering programs with the changes as little as possible over high-speed network**

Both IPTV and network technologies are progressing rapidly. IP networks are now getting larger capacity and lower cost year by year, thanks to the evolution of access and core network technologies. In the future, network capacity and cost may be enough large and low to provide IPTV services without need to transcode contents.

NOTE – Even though transcoding is not necessary, additional decryption and encryption may still be needed to satisfy business model requirements.

Such IPTV systems may be a candidate for low cost deployment cases. In this case, the same service as the latest broadcast service, UHDTV and/or IBB services, may be easily available as IPTV services in future.

Figure 6-1 illustrates the architecture of the original broadcast case (radio wave). In first this case, MPEG-2 [ITU-T H.262] encoded contents are delivered over radio waves. Figure 6-2 shows an IPTV case described in the Scenario 1. In this second case, ITU-T H.265 encoded contents are delivered over an IP network by using of a transcoder from the MPEG-2 format to the H.265 format in IPTV head-end (HE). Figure 6-3 shows another IPTV case described in the Scenario 2. In this third case, MPEG-2 encoded contents (which are the same as Figure 6-1) are delivered over an IP network. The contents are not transcoded, but they may be re-encrypted in the IPTV HE.

Table 1 shows the transcoding need and network bandwidth in each case.

Figure 6-4 shows the rough data stack in IP-STB in Scenario 2. The IPTV TD (basic model) may receive and decode contents, and display contents on a screen. The demodulation post processing in a broadcast receiver is the same as the post processing for removing the IP header in an IP-STB.
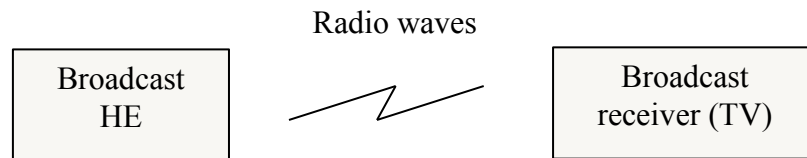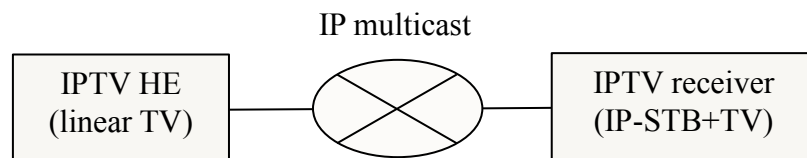
Video: ITU-T H.262

Figure 6-1 – Case 1: Broadcast
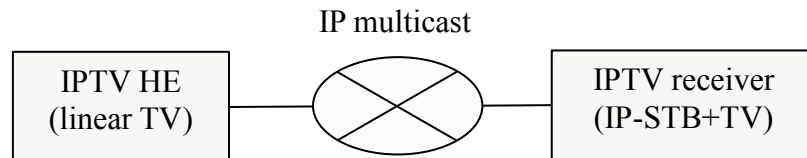
Video: ITU-T H.265

Figure 6-2 – Case 2: IPTV service for retransmission of broadcast service with transcoding
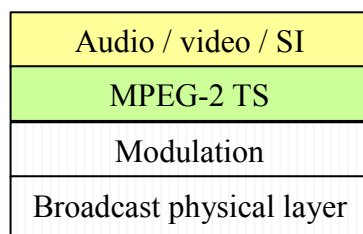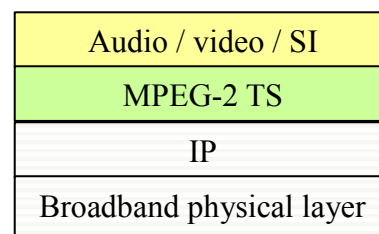

Video: ITU-T H.262

Figure 6-3 – Case 3: IPTV service for retransmission of broadcast service without transcoding

Table 1 – Transcoder necessity and network bandwidth

Case	Scenario	H.265 transcoder	Network bandwidth
Case 1	1	Unnecessary	H.262 equivalent
Case 2	1	Necessary	H.265 equivalent
Case 3	2	Unnecessary	H.262 equivalent

(a) Broadcast

(b) IPTV without transcoding

Figure 6-4 – Receiver protocol stacks

7 IPTV TD deployment for scenario 2

7.1 IPTV domain

Figure 7-1 shows an IPTV domain defined in [ITU-T Y.1910]. In this domain, the set-top-box (STB) connects with an IP network and TV in the end-user block.
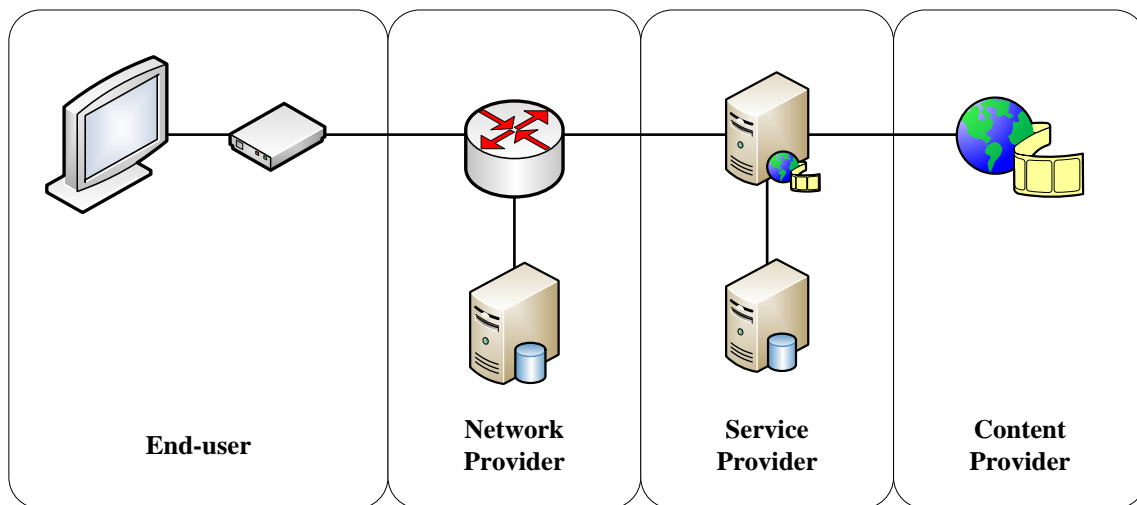

Figure 7-1 – IPTV domain [ITU-T Y.1910]

In order to consider the migration from ordinary broadcasting environment to an IPTV environment, the end-user devices (receiver environment) are considered in the following clauses. There are several variations of receiver environment, which need to support Recommendations related to end-user functions: [ITU-T X.1191], [ITU-T H.622.1], and [ITU-T H.720].

7.2 IPTV TD overview

An STB for IPTV services is called an IPTV TD. Figure 7-2 shows the functional architecture block diagram for IPTV TDs defined in [ITU-T H.720]. Figure 7-3 shows examples of IPTV TD interfaces [ITU-T H.720].

In the following clause, the IPTV TDs for scenario 2 are described based on these two figures. They are categorised in three types: STB, IBGW, and Connected TV with IPTV TD functions. Connections between DNG and these three types of IPTV TDs are shown in Figure 7-4.
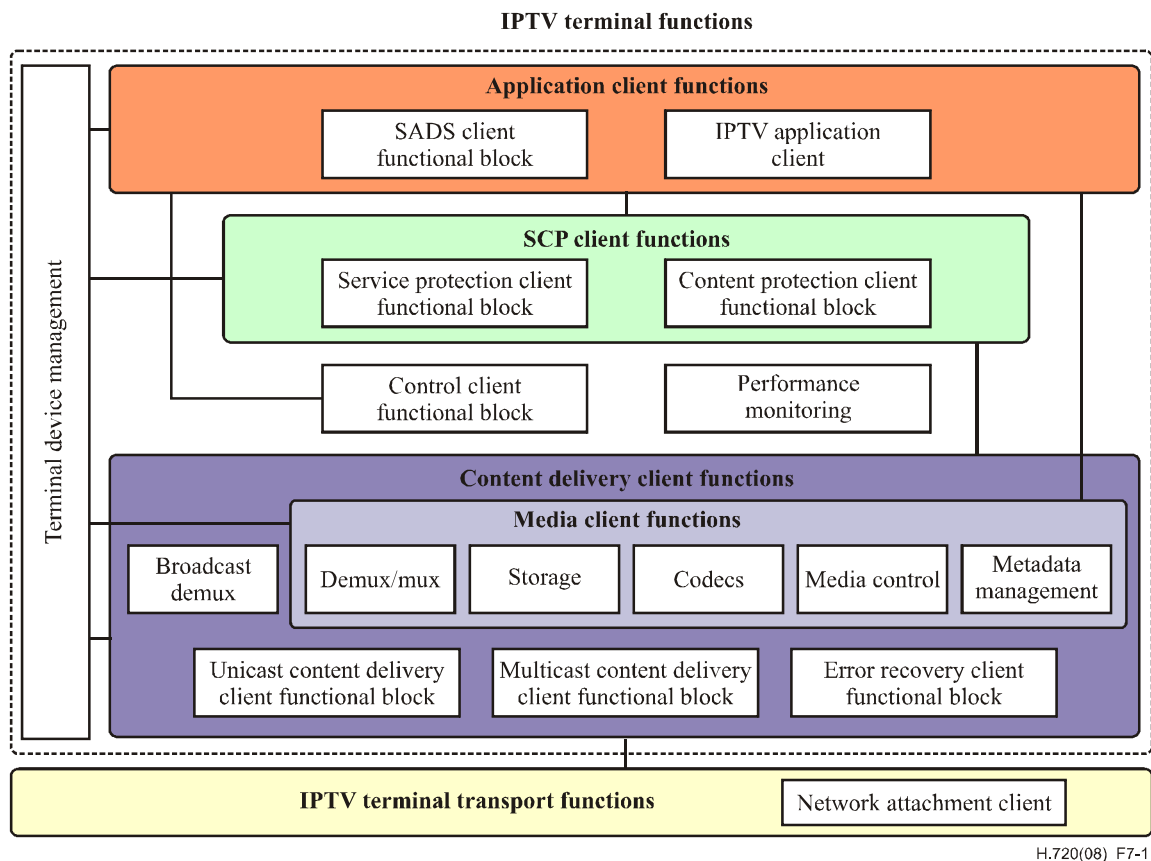
IPTV terminal functions

Figure 7-2 – Functional architecture block diagram of IPTV TDs [ITU-T H.720]
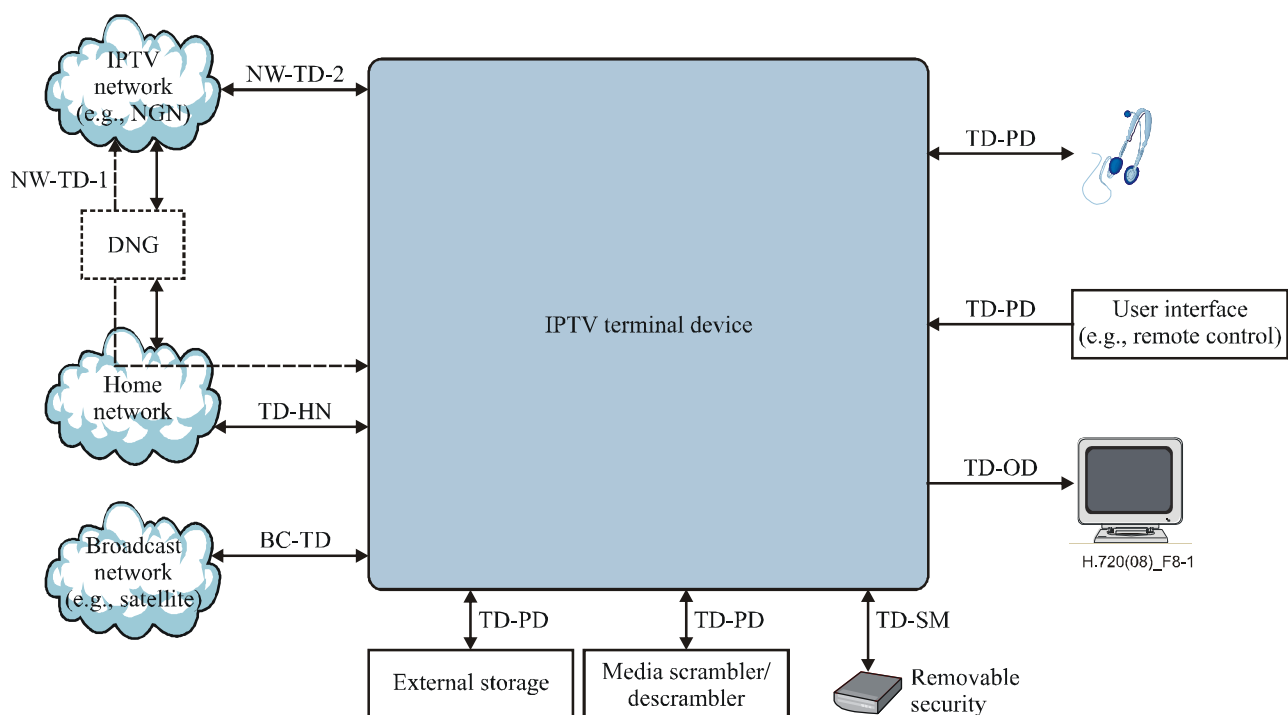
Figure 7-3 – Examples of IPTV TD interfaces [ITU-T H.720]

(1)   STB case

(2) IBGW case

(3) Connected TV with IPTV TD functions case
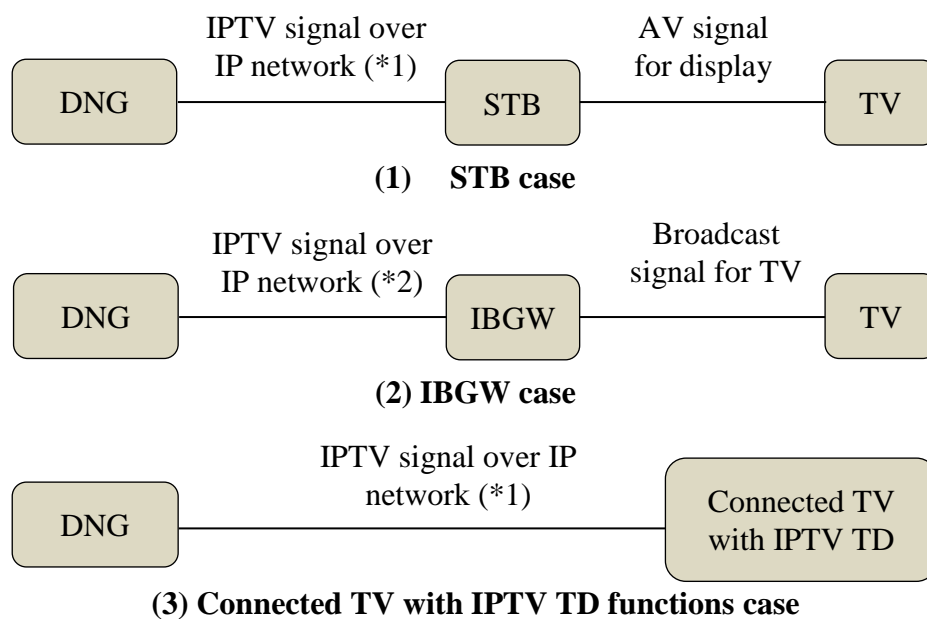
NOTE – (*1) IPTV signal over IP network of scenario 1 and/or scenario 2
(*2) IPTV signal over IP network of scenario 2

Figure 7-4 – Connections between DNG and end-user functions

7.3   IPTV TDs for scenario 2

7.3.1   STB

STB for scenario 1 (STB Type 1) has been defined in [ITU-T H.720]. Both codec in media client functions and SCP client functions (decryption functions) in scenario 1 are different from the ones in scenario 2. Therefore, STB Type 1 has different decryption and decoding functions from STB for scenario 2 (STB Type 2). STB Type 2 uses the same decryption function and decoding function as the original broadcasting uses. STB Type 2 is required to implement broadcasting decryption and broadcasting decoding function. STB Type 2 connects display through a TD output device (TD-OD). This interface is between an output device (e.g., display, home theatre system, external PVR) and an IPTV TD, and facilitates the transfer of audio and video signals from the IPTV TD to OD.

7.3.2   IBGW

IBGW is a variation of TDs for scenario 2. IBGW receives IP signals from the DNG and outputs broadcast signals to a broadcast network or TV. IBGW is not required to implement SCP client functions or codecs. In order to decrypt and decode input signal, these two functions in TV set are used. In order to use these two functions in TV, broadcast signal output by IBGW is almost the same as original broadcasting signal. This signal includes not only one service, but all of them. This broadcast signal is not TD-OD signals [ITU-T H.720]. Since SCP, codecs, TD-OD, TD-SM, and TD-PM are not implemented in IBGW, IBGW is not an STB. Physical output terminal of IBGW is a coaxial terminal for broadcast network with which several TV sets can be connected.

7.3.3   Connected TV with IPTV TD functions

Connected TV with IPTV TD functions is defined as a TV set that receives both broadcast signals and IPTV signals over an IPTV network. In scenario 2, decryption and decoder are the same as the original broadcasting. Connected TV with IPTV TD functions for scenario 2 does not require additional decryption and decoder functions for IPTV. The architecture of Connected TV with IPTV TD functions for scenario 2 may be simpler than that of Connected TV with IPTV TD functions Type 1.

Appendix I:

Delivery of IP-based broadcasting services over high-speed broadband

I.1   Overview

IP-based broadcasting systems such as ISDB-S3 [b-ITU-R BO.2098] [b-ITU-R BT. 2074] and ATSC 3.0 [b-ATSC 3.0] are under development. In these systems, broadcasting services are transmitted as IP packets, which are used in broadband networks. Since IP packets are a common interface between broadcast and broadband, broadcast channels can be used to deliver broadcasting services to broadband networks without making any changes to these services, such as by transcoding, replacing encryption for Conditional Access System (CAS) or Digital Rights Managements (DRM), or protocol conversion.

Figure I.1 illustrates the protocols used in IP-based broadcasting and broadband. A broadcaster is able to transmit its services by using the same protocols for broadcast channels as for broadband networks. A TV set can receive these broadcast services with the same protocols even though they are transmitted along different paths.
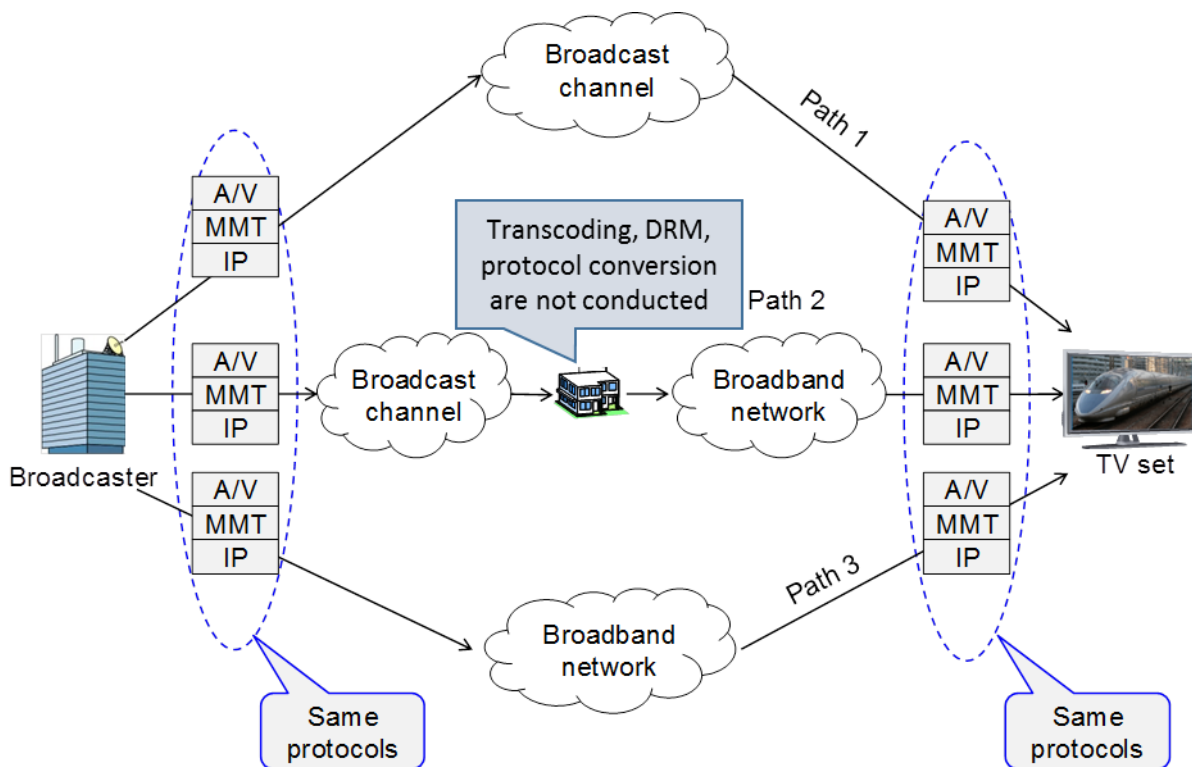
*A/V: Audio/Video *MMT: MPEG Media Transport [b-ISO/IEC 23008-1] *IP: Internet Protocol

Figure I.1 – Protocols in IP-based broadcasting and broadband

I.2   Differences between broadcast channels and broadband networks

The ISDB-S3 system uses MPEG Media Transport (MMT) [b-ISO/IEC 23008-1], a media transport protocol on top of IP, to transmit broadcasting services including audio, video, and other signals. In the Candidate Standard for ATSC 3.0, either MMT or DASH/ROUTE [b-ATSC 3.0] on top of IP are used to transmit broadcasting services. In any of these systems, IP packets carry the broadcasting services through the broadcast channel.

In the case of a broadcast channel, broadcast services are transmitted by multicasting UDP/IP packets to any receiver, as the channel is a unidirectional path. The broadcast channel for fixed reception provides quasi-error-free transmissions, because broadcast systems have a robust error correction mechanism in their physical layer.

In the case of broadband, both bidirectional transmission in the form of TCP/IP packets and unidirectional transmission in the form of UDP/IP packets are possible. However, network congestions may happen on the broadband network. Re-transmission of packets with the TCP mechanism or Application Layer-Forward Error Correction (AL-FEC) [b-ISO/IEC 23008-10] in combination with UDP is often used to keep quality high transmissions when packet losses occur.

I.3 Experiment on delivery of 8K programmes over broadcast and broadband

NHK (Japan Broadcasting Corporation) conducted an experiment in May 2016 in order to confirm that the ISDB-S3 protocol works through an actual broadband network without any modifications. Figure I.2 shows the experimental system.
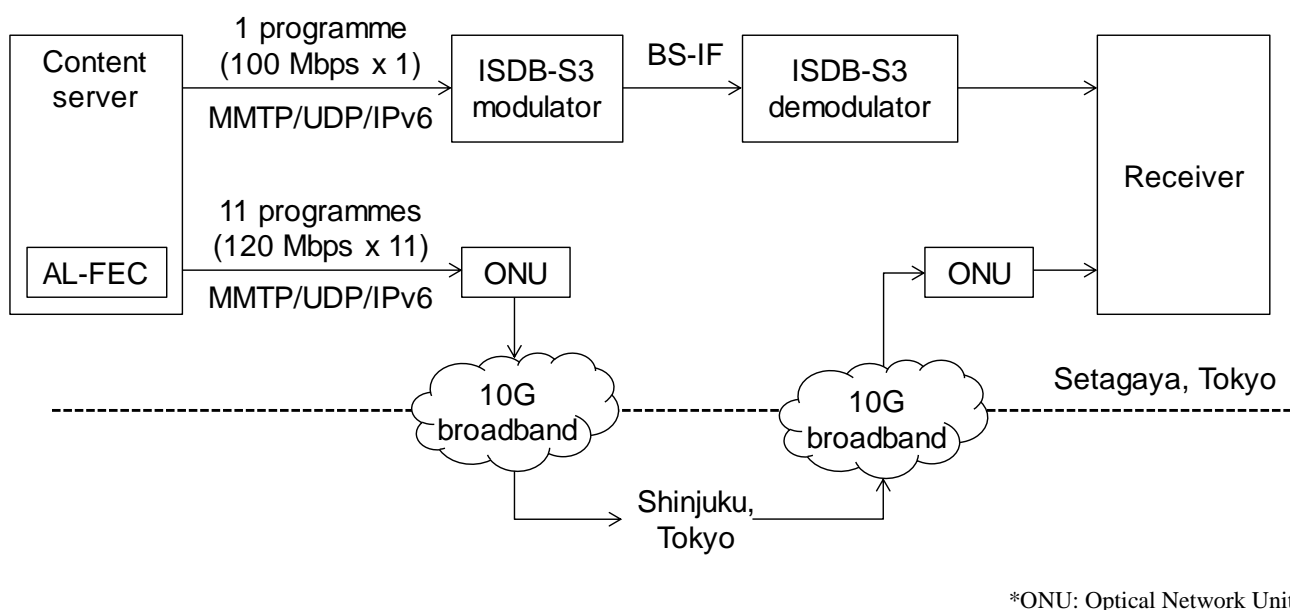

*ONU: Optical Network Unit

Figure I.2 – Experimental system using actual broadband network

The content server and receiver were located in Setagaya, Tokyo in Japan. The ISDB-S3 modulator and demodulator were connected back-to-back as the broadcast channel. A 10G-EPON (10 Gigabit Ethernet passive optical network) was used as the broadband network. The server transmitted one programme through an ISDB-S3 modulator and demodulator and eleven programmes through broadband.

Each programme consisted of encoded 8K video and two-channel audio signals. It was transmitted in real-time in accordance with their presentation time by using MMTP/UDP/IPv6 packets, whose bitrates were approximately 100 Mbit/s. Table I.1 lists the signals transmitted in the experiment.

Eleven programmes were transmitted from the server to Shinjuku, Tokyo, about 25 km away from Setagaya, Tokyo, at which point they were returned to the receiver in Setagaya. At this time, 10 Gbit/s services are available in limited areas of the Tokyo metropolitan region. Such service areas will spread throughout Japan in the near future.

In order to maintain error resiliency, the packet flows through broadband included repair packets generated by AL-FEC. The source packets through broadband were identical to those through the broadcast channel. The bitrate of one programme with repair packets was approximately 120 Mbit/s.

Table I.1 – Signals transmitted in experiment

Item	Configuration
IP version	IPv6
Transport protocol	MMTP/UDP
IP packet size	Max. 1.5 KB
Audio	Format: Two channels Coding: MPEG-4 AAC LC
Video	Format: 7680x4320/59.94/P Coding: HEVC main 10 profile [HEVC]
Bit rate	100 Mbit/s

The receiver chose one of the twelve programmes from either broadcast or broadband and displayed it after extracting the AAC/HEVC streams from the received MMTP packets and decoding them.

Figure I.3 shows the content server and receiver. The monitor on the left shows the status of the content server that transmitted the twelve programmes in real time: one for broadcast and eleven for broadband. The monitor on the right shows the received 8K programme that a user selected.
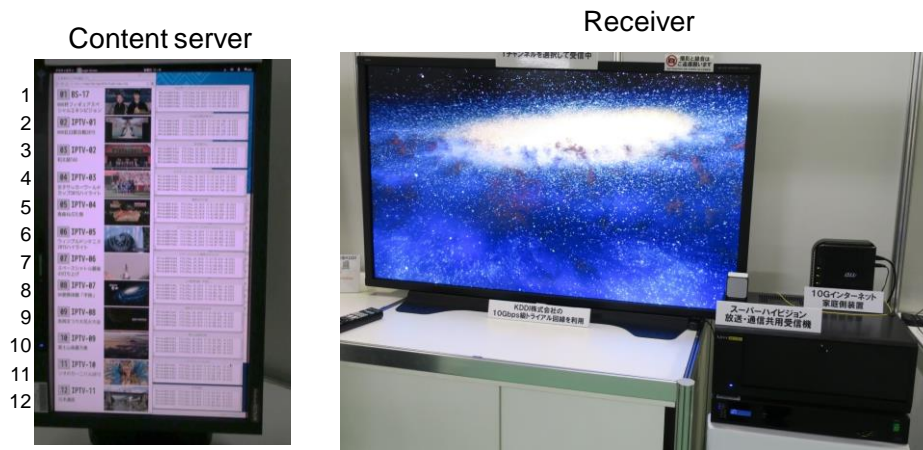

Figure I.3 – Content server and receiver

During this experiment, the receiver stably presented the 8K programme selected by the user. Users could choose the programme they wanted to watch without having to worry about its delivery path.

A receiver that did not support the AL-FEC function received IP packets including the repair packets. In this case, the receiver could ignore the repair packets and processed only the source packets. There was no packet loss during the 24-hour period in which the eleven 8K programmes were delivered.

This experiment confirmed that the protocol of ISDB-S3 on top of IP correctly worked through broadband.

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[b-ISO/IEC 23008-1]   ISO/IEC 23008-1:2014: *Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 1: MPEG media transport (MMT).*

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[b-ISO/IEC TR 23008-13]   ISO/IEC 23008-13:2015: *Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 13: MMT implementation guidelines.*

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